Feasibility of a Texting Intervention to Improve Medication Adherence Among Older HIV+ African Americans: A Mixed-Method Pilot Study

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Abstract

Antiretroviral therapy (ART) is the primary treatment for HIV, and adherence to it is crucial to addressing health disparities. Approximately half of individuals in the United States living with HIV are African Americans, and those over 45 years of age are more likely to die early from HIV/AIDS than their White counterparts. This mixed-method pilot study evaluated the feasibility of a text-based mobile phone intervention designed to improve ART adherence among older African Americans with HIV. Feasibility was assessed via implementation, participant adherence, acceptability, and satisfaction, as well as short-term impact on medication adherence, adherence-related self-efficacy, and positive affect. The intervention utilized pill reminder, motivational, and health educational texts. Participants (N = 21) ranged in age from 50 to 68 years. Outcomes were evaluated via quantitative results from self-report measures and qualitative data from four focus groups. Attrition to the study was 100%. After 8 weeks, participants reported statistically significant improvements in medication adherence, but not in self-efficacy or affect scores. Qualitative findings highlight the psychologically supportive potential of the intervention, challenges to adherence, as well as suggestions for improvement. The study demonstrates that a text messaging intervention may be feasible for older African Americans with HIV, and helpful in supporting ART adherence.

Background

Antiretroviral therapy (ART) is universally accepted as the primary treatment for HIV, with the World Health Organization (2015) strongly recommending that all persons with HIV be treated with ART. ART adherence is imperative to reducing health disparities related to HIV, which are most pronounced among African Americans (Centers for Disease Control and Prevention [CDC], 2017). Although African American patients are disproportionately affected by HIV/AIDS, they are less likely than White patients to receive ART, be adherent to ART, and/or achieve viral suppression (CDC, 2017; Pence et al., 2008; Silverberg, Leyden, Quesenberry, & Horberg, 2009).

Older HIV+ African Americans between the ages of 45 and 64 years are particularly at risk of premature death from HIV/AIDS. Data show they are up to 16 times more likely to die early from HIV/AIDS than their White, non-Hispanic counterparts (U.S. Department of Health and Human Services, 2016). The intersection of HIV status and older age, therefore, becomes a particularly dangerous one for African Americans. The presence of HIV in the body can worsen age-related memory problems, which can make ART adherence that much more challenging (Barclay et al., 2007; Insel, Morrow, Brewer, & Figueredo, 2006). This population also experiences a higher rate of comorbid chronic conditions such as depression, cardiovascular disease, diabetes, and certain types of cancer (Balderson et al., 2013; Buchacz et al., 2013). This article presents the results of a

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mixed-method pilot study to test an individually tailored, culturally sensitive mobile phone intervention to support ART adherence and other health-related behaviors among older HIV+ African Americans.

Issues with Medication Adherence

Many chronically ill, older African American patients, including those with HIV, suffer from disparities in health outcomes due in part to medication adherence barriers (CDC, 2015; Johnson et al., 2003; Konkle-Parker, Erlen, & Dubbert, 2008). To support medication adherence in this population, for both HIV and common comorbidities, it is important to identify potential barriers to adherence, and offer solutions to overcome those barriers. ART adherence in older HIV+ adults has been predicted by an individual's cognitive status, with worse adherence driven by decrements in learning, memory, and executive functioning (Bianco, Heckman, Sutton, Watakakosol, & Lovejoy, 2011). Older HIV+ African Americans may be at an increased risk for memory barriers to ART adherence for a number of reasons. First, normal changes due to cognitive aging can interfere with medication management and adherence for any older patient group (Sino, Sietzema, Egberts, & Schuurmans, 2014). Second, HIV infection itself can accelerate cognitive decline (Chou, Ramirez, Wu, & Effros, 2013). Third, acute and chronic stress arising from discrimination and socioeconomic differences between White Americans and ethnic/racial minorities has been found to increase allostatic load in minority individuals, potentially leading to further decrements in memory and cognitive processes (Djuric et al., 2008; Juster, McEwen, & Lupien, 2010). In addition, psychosocial factors such as stress burden, lack of perceived support, a sense of hopelessness, and lack of ART self-efficacy have been shown to affect adherence and negatively affect the maintenance of healthy behaviors among African American patients (Emlet, 2006; Huang et al., 2013; Stewart, Cianfrini, & Walker, 2005; Webel et al., 2014; Whitehead, Hearn, & Burrell, 2014).

Technology and Health Disparities

Although there have been successful in-person interventions for improving medication adherence for persons with HIV (Kalichman et al., 2011; Wang et al., 2010), cost and other access barriers (e.g., transportation) have stood in the way of widespread implementation. In addition, interventions targeting adherence have rarely been created to meet the specific needs of older, HIV+ African American patients (Mathes, Pieper, Antoine, & Eikermann, 2013).

Mobile phones are an increasingly common choice for the delivery of medication adherence support to African American patients because of cost-effectiveness and accessibility. Pew data show that 89% of African Americans aged 50 to 64 years own mobile phones,

along with 77% of African Americans aged 65 years and above (Smith, 2014). Text messaging is the most widely used feature of mobile phones, with 92% of mobile phone owners aged 50 years and above having used this feature in the last week (Smith, 2015). Furthermore, research has shown that, on average, African Americans send and receive significantly more text messages than White Americans (Smith, 2011). Text messages are inexpensive and can be accessed by those using older (nonsmart) cell phones. Both the CDC (2014) and HIV. gov (2009) recommend using mobile health (mHealth) tools to reach underserved patient groups, including ethnic minority and HIV+ patients.

Text-based interventions have been used to support both medication adherence and specific behaviors related to health and well-being. For instance, a large clinical trial that combined pill reminders, motivational, and health education texts showed significant reductions in several cardiovascular risk factors (Chow et al., 2015). In HIV/AIDS research, trials relying on text messaging have proven successful in maintaining and/or increasing ART adherence (da Costa et al., 2012; Ingersoll et al., 2015; Lester et al., 2010; Mbuagbaw et al., 2015; Shet et al., 2010). Although research findings in this area have supported the use of text messaging for ART adherence (Amico, 2015; Finitsis, Pellowski, & Johnson, 2014), results on the effectiveness of these interventions have been mixed. For example, while a recent study using text messaging to support adherence found a small increase in patient's ART adherence (Georgette et al., 2017), Kalichman and colleagues (2016) found that text message reminders as a standalone intervention did not have an effect on ART adherence.

Purpose of Study

Although there have been successful HIV medication management interventions for adults, to the best of our knowledge, none have been specifically designed for HIV+ African Americans, aged 50 years and above. The intervention described in this article was developed with focused consideration on the particular challenges created by the intersections of age, race/ethnicity, and health status. The objective of this pilot study was to test the feasibility of an 8-week texting intervention to improve ART adherence among older African Americans with HIV. Research questions focused on feasibility and short-term impact of the intervention on medication adherence and related psychosocial outcomes.

Method

The study design was a single-arm, mixed-method pilot trial with the following aims: to develop a tailored, mobile phone text message intervention to promote adherence to ART and co-occurring chronic illness medications among African American adults with HIV, aged

50 years and above, and to evaluate its feasibility. Feasibility of the intervention was assessed by evaluating the following: (a) implementation, (b) participants' acceptability and satisfaction, and (c) short-term impact on medication adherence and psychosocial outcomes related to adherence (i.e., self-efficacy and affect). All study procedures and materials received approval from an Institutional Review Board.

Recruitment

We aimed to recruit 35 individuals based on a prior needs assessment report conducted by a state agency. We anticipated approximately 20% participant attrition, which would result in 28 participants at study conclusion. Inclusion criteria were the following: individuals, aged 50 years and above, who self-identified as African American, HIV+, currently on ART, and who had difficulty remembering to take pills or occasionally chose to skip ART pills. Participants needed to own a mobile phone that could receive texts and be willing to keep their phone on during the study period. Exclusion criteria were as follows: dementia diagnosis; diagnosis of other life-threatening illnesses such as cancer; lack of cell phone; current participation in other research studies, including undergoing exploratory treatments for HIV or other illnesses; and/or discomfort with the potential privacy loss risks associated with the study.

Recruitment occurred in a large urban city in the east coast of the United States. Participants were recruited through the following: regional ads posted on Craigslist, announcements distributed to members of the local department of public health's statewide community advisory board on HIV, ads distributed at HIV support groups within local health centers, and snowball sampling. Participants were eligible to receive US$125 at the end of the 8-week trial, as well as 25 cents of reimbursement for each text received as part of the project.

Theoretical Foundation of Intervention

The theoretical bases for the intervention include the Health Beliefs Model and Social Cognitive Theory. As psychological factors play a role in adherence, researchers have postulated that the Health Beliefs Model (DiMatteo, 2004; Rosenstock, 1974) would prove useful in understanding medication adherence related to HIV (Barclay et al., 2007). Indeed, Gao, Nau, Rosenbluth, Scott, and Woodward (2000) found that health beliefs (e.g., perceived susceptibility to illness) predicted medication adherence. Moreover, research shows that positive beliefs about ART treatment, specifically, may promote adherence among African Americans with HIV (Sayegh et al., 2016). Social cognitive theory (Bandura, 1977, 1986) posits that individuals need to believe in their own ability to execute specific behaviors. This concept of self-efficacy has also been linked to HIV medication adherence (Gifford et al., 2000; Johnson et al.,

2003; Molassiotis et al., 2002). Finally, belief that one can successfully reduce risk through one's own behavior is central to treatment self-efficacy (Witte, 1995).

Intervention Design

The texting software platform was developed in collaboration with members of the University of South Carolina's Department of Computer Science and Engineering. Text messages were created by a team made up of HIV peer advocates, clinical care experts, and health communications experts. The team was diverse in terms of race, ethnicity, culture, age, and professional/educational background. The team also included an infectious disease specialist who was the director of a large urban HIV clinic.

Based on the outlined theoretical foundations and the challenges created for the target population by the intersection of age, race, and health status, an automated text messaging system was created that enabled investigators to send (a) personalized daily pill reminders for ART and other chronic illness medications, delivered according to dose frequency (to target memory impairment and executive dysfunction); (b) health education messages targeting health beliefs and providing general strategies to support adherence, delivered biweekly; and (c) motivational messages targeting self-efficacy and promoting positive affect, also delivered biweekly.

Procedure. Individuals called the project coordinator to learn more about the study and, if interested, completed a phone screening to confirm eligibility. Those deemed eligible were invited to participate and scheduled for an in-person session. During this first baseline session participants completed a consent form (including consent for focus group participation and to participate in the 8-week trial) and the measures described below. In addition to those measures, basic demographic data (i.e., age, gender, ethnicity, length in years of HIV diagnosis) and medication information were collected. When participants were scheduled over the phone, they were asked to bring a list of the names of their medications.

At the baseline session, participants indicated which medications they wished to receive pill reminders for by filling out a form. A study team member double-checked the form with participants to ensure accuracy. Participants' mobile phone numbers and self-reported pill regimens (type and frequency) were then entered into the texting software platform by a study team member. Participants were informed that if during the study they experienced a medication change, they could call to change the information in the system. To further ensure medication accuracy, a weekly text was sent out stating the following: "If your medication has changed and you would like to change the pill reminder for it, please call [name] at [number]."

During the 8-week study period, participants received daily pill reminders and alternating biweekly motivational and health educational messages. The frequency

Table 1. Research Questions and Method/Measures.

Research question	Method/measure
Is the implementation of this program, as planned, possible?	1. Text message system delivery (via platform log and self-report)
	2. Participation and recruitment outcomes
Is this intervention acceptable to participants?	1. Focus group (postintervention)
Is this intervention of satisfaction to participants?	1. Focus group (postintervention)
Does the intervention have any short-term impact on participants' medication adherence?	1. Focus group (postintervention)
	2. Three-item ART use measure (Segeral et al., 2010)
Does the intervention have any short-term impact on self-reported improvements of participants' psychosocial outcomes related to adherence?	1. Focus group (postintervention)
	2. HIV-ASES (Johnson et al., 2007)
	3. Subjective Happiness Scale (Lyubomirsky & Lepper, 1999)

Note. ART = antiretroviral therapy; ASES = Adherence Self-Efficacy Scale.

Table 2. Dependent (Paired) Samples *t* Tests Results for Self-Efficacy and Affect (*N* = 21).

Measure	Baseline		8-week follow-up				
	M	*SD*	*M*	*SD*	*t*	*df*	*p* value
HIV self-efficacy	67.71	12.33	68.19	12.53	1.88	20	.07
Affect	16.14	4.89	17.38	4.95	0.83	20	.42

of the daily pill reminders had been chosen by participants and customized for their profile in the texting software platform (e.g., "Remember 6PM Truvada"). Because medications for different conditions may be taken simultaneously, texts were "bundled" whenever possible to send one text with reminders for several medications. Concerns about privacy were paramount in terms of protecting participants in this study. To address such concerns, participants were given the option of ART pill reminder messages that did not specifically reference ART drug names. None of the participants chose to disguise pill reminder texts in this way.

At the conclusion of the study, participants returned for a follow-up session during which they re-took measures. During this follow-up session, researchers conducted focus groups with participants to elicit open-ended feedback on the implementation of and satisfaction with the intervention, including suggestions for improvement.

Measures

See Table 1 for list of measures and research questions.

Quantitative. Implementation of the intervention was measured by calculated percentage of successful delivery of text messages (by platform log and self-report), percentage of text messages read (by self-report), percentage of individuals recruited, and retention of individuals in the study. Adherence was assessed using Segeral et al.'s (2010) three-item self-report measure examining ART use in the prior 4 days, a time period considered a reliable indicator of overall adherence (Bianco et al., 2011; Spire et al., 2008). The measure consists of a yes or no response to each of the following

three questions: (a) "Did you miss any ART doses during the last four days?"; (b) "Were you late for any of your intakes by more than two hours during the last four days?"; and (c) "Did you miss any ART doses last weekend?" Adherence was considered perfect if participants reported "no" to all questions.

Adherence self-efficacy was assessed using the HIV Adherence Self-Efficacy Scale (HIV-ASES), a 12-item self-report scale of patients' confidence in carrying out behaviors related to treatment adherence, including taking medications in the face of barriers (Johnson et al., 2007). For example, the scale asks, "How confident are you that you can stick to your treatment plan when side effects interfere with daily activities?" Reponses range from 1 ("cannot do at all") to 10 ("completely certain can do").

Affect was measured using the four-item self-report Subjective Happiness Scale, which is designed to measure "lasting" happiness, as opposed to "transient" mood states (Lyubomirsky & Lepper, 1999). Each item is completed by choosing one of seven options that finish a given sentence fragment, such as "Compared to most of my peers, I consider myself . . ." Responses range from 1 ("less happy") to 7 ("more happy").

Qualitative. At 8 weeks, after completing the measures, participants were invited to discuss their experiences in a focus group. Focus groups were carried out with a semi-structured interview guide that included questions targeting the following: (a) whether the intervention was acceptable to participants and, if not, what components were undesirable, (b) whether participants comprehended the information provided in the intervention, and (c) suggestions for improvement. Particular questions focused on addressing the cultural appropriateness of

the intervention, including whether the intervention was appealing, useful, and relevant for individuals in this specific age and race group.

Data Analyses

Quantitative data were analyzed using R Studio. Demographic and participation data were described as means (standard deviations [*SD*]) or counts. Dependent samples (paired) *t* tests were performed to assess any changes between baseline and follow-up scores in self-reported ART adherence, adherence self-efficacy, and affect. Significance was set at $p < .05$.

Qualitative data were obtained solely through focus groups. Two researchers with graduate degrees in psychology and training in interviewing techniques conducted the focus groups. These groups were digitally audio recorded, transcribed, and analyzed by the same researchers according to qualitative principles outlined by Corbin and Strauss (2008). Recordings and transcripts were kept under password protection. Identifying information was redacted from the transcripts. Data were analyzed thematically (Braun & Clarke, 2006), which involved identifying patterns that related to participant experience with the intervention. The transcripts were first analyzed by two researchers in isolation using line-by-line coding to identify repetition of specific words, phrases, and belief statements. Researchers then reviewed and discussed the codes together to reach consensus and identify broader themes in and across groups. Themes were only identified if they were prevalent in each focus group.

Quantitative Results

A total of 38 individuals called the study coordinator and were screened for participation. Of those, 29 were eligible, but eight declined to participate due to constraints related to time and transportation. This yielded a final sample of 21 participants, which included 11 females and 10 males. The age range of participants was 50 to 68 years, with a mean age of 55 years (*SD* = 5.4 years). Length of HIV diagnosis ranged from 5 to 29 years, with a mean length of 22 years (*SD* = 6 years). The texting software platform performed without any apparent errors and logged that 100% of the text messages were successfully sent. At follow-up, participants reported receiving and reading 100% of the text messages.

There was no attrition in participation, and 100% of participants completed the follow-up measures. At study follow-up, 86% of participants reported perfect ART adherence in the last 4 days, compared with only 38% of participants with perfect adherence at baseline. Results of the dependent samples *t* tests showed that there was no significant statistical improvement in HIV treatment self-efficacy or affect scores (see Table 2 for results). Although self-efficacy and affect scores did not show significant changes, qualitative findings (outlined

below) suggest the intervention was experienced as psychologically supportive.

Qualitative Findings

A total of four focus groups were conducted at the conclusion of the study. Two of the focus groups comprised six people, a third group comprised four people, and a fourth group comprised five people. Three main themes were identified from focus group discussions. The first theme centered on adherence—the help that the intervention was able to provide, as well as the unique challenges of being adherent to medication for a chronic illness. The second theme centered on participants' emotional experience of the intervention, particularly feeling supported and cared for as a result of receiving the text messages, and the impact this had on them. A third theme captured the limitations of the intervention as experienced by the participants, as well as their recommendations for modifications in future iterations of the intervention.

Challenges of Adherence

Adhering to ART was seen as a challenge due to the inconvenience of taking medication daily, the side effects, and most notably, that taking ART was considered a reminder of the permanence of the HIV diagnosis. Participants spoke to the psychological pain of being diagnosed with HIV and facing a lifetime of medications with significant side effects, as well as their heightened vulnerability to opportunistic infections. Although participants all reported accepting their ART treatment over time, there was a theme of initially rejecting it because of what it represented:

> When I was first diagnosed, first thought that goes through my head is, "I gotta take these pills for the rest of my life?" I'm not doing that. Hell with it.

The problem of forgetting pills came up in discussions, with one participant noting that the intervention helped her to finally reach 100% adherence. Notably in this older population, there was a theme of forgetting, especially at bedtime. Several participants reported episodes of falling asleep without taking their evening ART dose, only to be awakened by a pill reminder text message.

The messages also helped prevent intentional "drug holidays," or deliberate skipping of pills. Drug holidays were seen as temporarily relieving the psychological pain of HIV which, while less intense than at the time of diagnosis, persisted even among long-time ART adopters:

> At least for me, got a lot of [medications], because you can be compliant taking your medications and then your doctor goes "Oh you got cervical cancer, oh, you have hep c." It's a whole lot of other stuff. And that'll throw you for a loop . . . Like I said I'm very adherent, but I've considered taking a drug holiday.

Support and Care

Participants were especially enthusiastic about the messages supporting their general health. They saw these particular messages as valuable for two reasons: (a) these offered support for aspects of their health that they often neglected, such as healthy eating and exercise, and (b) the simple fact of receiving text messages, and sensing that someone was reaching out to them, felt supportive. Participants reported this response to both educational and motivational messages. Prior studies have shown that patients with HIV who report being more satisfied with their interpersonal interactions from treatment providers are more likely to adhere (Thrasher, Earp, Golin, & Zimmer, 2008):

> I call [the texts] caring reminders . . . Because somebody is caring about me and remind me to take my meds. Another support mechanism.

The benefits of receiving information about their general health seemed evident given the way participants responded to these particular text messages. It appears that focusing on other aspects of health, and ways to improve their quality of life outside of HIV, created more of an impression on the participants than reminders about taking their medication—possibly because other aspects of their health have been or seem to be overshadowed by the enormity of their HIV diagnosis. Small changes, affected by reminders such as to drink a sufficient amount of water, or to get regular exercise, seemed to have made a difference in how the participants experienced more healthy lifestyles:

> I haven't deleted them yet. You know. They're still just little things I like to look at anyways. I was looking forward to them.

Although we were unable to explore this contrast directly, it is possible that the positive response was due to the fact that the motivational and educational messages were more personally engaging. As mentioned earlier, pill reminders were experienced by some as a reminder of their HIV diagnosis. Even though many participants were involved with support groups, community activism, clinical studies, and had friends with HIV, they still felt isolated at times, as if he or she were struggling alone, invisible in a world of people unaffected by the illness. Thus, the small changes and ideas promoted by the texts (i.e., eat more whole grains, walk more, laugh more, reach out to friends) may have felt both manageable and emotionally supportive:

> I really like that one saying, *Staying healthy allows you to do the things that you enjoy*.

Health education messages were appreciated for being non-HIV specific, as participants expressed the sentiment that, due to HIV, they often neglected other aspects of their health, and it was helpful to be reminded to pay attention to diet and exercise. During the discussions, several participants spontaneously discussed challenges they faced in their efforts to stop smoking. Receiving personalized messages that promoted healthy living seemed to have a beneficial effect on participants:

> I was looking forward to them, for me. You know I was looking forward to them. 'Cause like I said, it enhanced me, to staying on the road I was on.

HIV can be isolating and carries with it a heavy burden of medication responsibilities and the stress of dealing with social and emotional stigma. That social isolation, self-imposed or otherwise, can have an adverse effect on the health of those living with HIV, and it appears from the participants' responses that text messages helped reduce feelings of isolation.

Limitations of the Intervention and Recommendations From Participants

Focus group questions sought suggestions for improvement of the intervention. Participants observed that ART pill reminders would be most helpful to patients *directly* after diagnosis, when there is a strong likelihood that a patient might not adhere to their medication regimen:

> But for me, when you're newly diagnosed, and you have to make a commitment to take those pills, that's not happening right away. Because you have to have acceptance to take those pills right away. You have to get acceptance to be adhering to the medication. A lot of times there's side effects, a lot of times there's—you just want to ignore that piece. Every morning you get up to take those pills is a reminder that you have HIV AIDS. And sometimes, you don't want to hear that.

Another suggestion was that the health education texts could be expanded to include more statistics about HIV that may be supportive to those who live with the illness:

> I think some nice facts in there would be nice. I think there was one that said *Taking your HIV meds daily is really important*, something like that, and maybe like estimates to say how many people live longer if they take their meds.

Participants discussed the potential value of connecting to a live, caring professional as key when adherence was a challenge, especially for individuals who have just received an HIV diagnosis. They expressed a desire for a more interactive intervention. Many texted messages back to the team in response to their pill reminders, even though responses were not required. Pill reminders were seen as valuable memory aids, and good for occasional lapses, but insufficient for people who were truly struggling with adherence, as reflected in the following quotes:

> I think for people who occasionally have a problem with missing their medication or something, [pill reminder texts] may work for them. But for somebody who is newly diagnosed, they need more support around taking their medication. And not just a text message.

> And a live person is gonna talk to them. "Is there a problem? What's going on? Can I help?" You have to ask them. Because, I'll tell you the truth, you calling me . . . [makes] a world of difference.

Discussion

This project represents a novel effort to develop and evaluate the feasibility of a tailored multifaceted mobile phone-based medication adherence intervention for older, HIV+, African American adults—a group disproportionately affected by HIV. The intervention aimed to (a) remind individuals to take their ART medication, (b) to target psychological factors that can influence adherence (i.e., motivation and affect), and (c) target co-occurring chronic conditions and lifestyle behaviors among HIV+ patients, such as healthy diet and physical activity, which can affect morbidity. Unlike other interventions, this one did not require online access and did not require any level of computer literacy.

The combination of daily pill reminder text messages with biweekly motivational and health educational text messages was associated with significant improvements in ART adherence over the course of 8 weeks. Our findings are consistent with research showing pill reminder systems are effective adherence aids when nonadherence is unintentional, as can be the case for older adults (Harbig, Barat, & Damsgaard, 2012; Rolnick et al., 2011). Despite nonsignificant quantitative results, qualitative findings suggested that motivational texts may help prevent intentional nonadherence (i.e., "drug holidays") and in other ways may help lessen the psychological burden associated with HIV and medication adherence. Our results suggest that the synergy of mobile phone-based pill reminders with motivational and health educational messages are a potent, feasible, accessible, and low-cost intervention for older HIV+ African Americans.

Although the intervention was designed to target unintentional nonadherence, some of the participants noted that the messages were helpful in preventing intentional nonadherence. Patient education is one of the most effective methods for supporting adherence across patient groups (Dayer, Heldenbrand, Anderson, Gubbins, & Martin, 2013). Yet, access barriers can limit the availability of patient education to minority patient groups (Price, Khubchandani, McKinney, & Braun, 2013; Schaafsma, Raynor, & de Jong-van den Berg, 2003). The ideal medication adherence intervention would bring together all the evidence-based methods—pill reminders, medication counseling, behavioral reinforcement, patient education—but is rarely, if ever, done

(Dayer et al., 2013). Furthermore, automated text messages (as used in this study) offer distinct advantages over live messages sent in "real time," in terms of cost-effectiveness, implementation, and scalability potential.

Findings from this study point to a number of considerations that may inform future research directions. When this program was created, a review had identified eight HIV-specific mobile apps that were commercially available, none of which had been clinically evaluated (Muessig, Pike, Legrand, & Hightow-Weidman, 2013). Although mobile apps in Muessig et al.'s (2013) review included a number of interactive tools, for example, for ART adherence tracking and reminders, medication interaction information, medical appointment calendars and reminders, doctor/clinic names and locations, symptoms/side effects trackers, and viral load/lymphocyte (CD4) cell count trackers, none of the apps included interactive motivational or educational support resources. Muessig and colleagues (2013) concluded that additional mHealth tools were needed to promote HIV medication adherence, support clinical monitoring, and facilitate patient–provider relationships. One such mechanism suggested is providing linkages between the user/patient and his or her health care team, and the inclusion of real-time support. Suggestion of this mechanism is supported by our participants' desire for a more interactive intervention and for connecting to a live professional. Participants in our study identified the potential added value of contact and counseling from a supportive professional within the context of a mobile phone-based medication adherence intervention, which also includes the use of automated reminders.

Study limitations include length of follow-up It is unclear whether adherence would be sustained over a longer period of time. Relatedly, while many of the text messages addressed adherence directly (e.g., "You've got what it takes to stay on your meds") and treatment self-efficacy was a study outcome, additional measures of behavior change, beyond ART adherence and self-efficacy, would strengthen study results. Furthermore, the study relied only on self-reported data, as is often the case with adherence studies. However, measures using pill counts and blood levels are always ideal. Another limitation had to do with our sample size. We recruited 38 participants, but challenges related to scheduling and transportation prevented some eligible individuals from participating. An intervention with a larger sample, and one that examines long-term effects on ART adherence, with the possible inclusion of ART blood levels, would offer more clear evidence of potential benefit.

Conclusion

In summary, this intervention addressed two major barriers to ART adherence among HIV+ older adults: memory and executive dysfunction that might affect ability to adhere and affect (Barclay et al., 2007; Johnson et al.,

2003). The intervention was novel in four ways: (a) focus on African American adults with HIV, who are over the age of 50 years, a rapidly growing group for which few-to-no interventions have been developed; (b) using accessible, inexpensive mobile phone technology, which has been underutilized in the United States to promote HIV adherence particularly among this group; (c) targeting HIV and co-occurring chronic conditions, rather than HIV alone, thus strengthening the intervention's potential impact on health outcomes and the reduction of health disparities among older African Americans with HIV; and (d) developing, evaluating, revising, and employing culturally sensitive messages individually tailored to a participant's medical conditions and pill regimens.

Our study results suggest that the synergy of mobile phone-based pill reminders with culturally sensitive motivational and health educational messages is a feasible intervention for older HIV+ African Americans and may promote ART adherence. Our qualitative results, taken together with identified gaps in mHealth interventions, suggest that the benefits of such an approach are both practical and emotionally supportive. The addition of support in the form of real-time access to a professional who could provide medication, educational, and motivational counseling could provide even greater benefits.

Author Contributions

Patricia Flynn Weitzman was the principal investigator for this study; Patricia Flynn Weitzman and Sue E. Levkoff conceived and designed the intervention; Paul Goulet and Laura Kogelman contributed to intervention design and recruitment; Patricia Flynn Weitzman and Marta E. Pagan-Ortiz conducted the intervention; Patricia Flynn Weitzman and Marta E. Pagan-Ortiz analyzed the data; Marta E. Pagan-Ortiz wrote the paper. All authors have read and approved the final version of this manuscript.

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